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A61B 18/00

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GB 2380679 A
US 6458125 B
US 5451222 A
US 5154709 A
EP 0447121 A2
US 6146353 A
US 5224944 A

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(54) Abstract Title: **Electro-surgical pencil and smoke evacuation apparatus**

(57) An electrosurgical pencil comprising an elongate body having a distal end 90 and a near end, a mount (14, FIG 1), at the distal end of the body for mounting an electrode 18 whereby the electrode in use extends from the elongate body, electrical wiring disposed within the body and extending out of the near end of the body for connection to a source of electrical power, the electrical wiring being electrically connected to the mount for electrical connection, in use, to the electrode, a smoke evacuation shroud 54 surrounding the electrode and a connector located on the elongate body at a location spaced from the distal end, the shroud being removably connected to the connector 56 and enclosing a part of the distal end of the elongate body which is distal of the connector, and the connector having a connection element for connection to an aspirator tube 52 of a smoke evacuation apparatus.
Figures 10 and 11 show a suction pump for smoke aspiration having inlet and outlet filters. Figures 12 and 13 show a current sensor for triggering synchronised operation of the suction pump with sensed operation of the electro-surgical pencil.

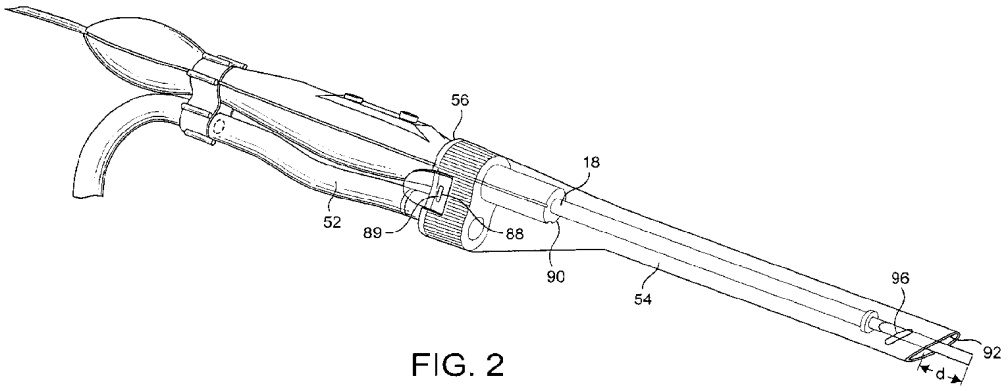

FIG. 2

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

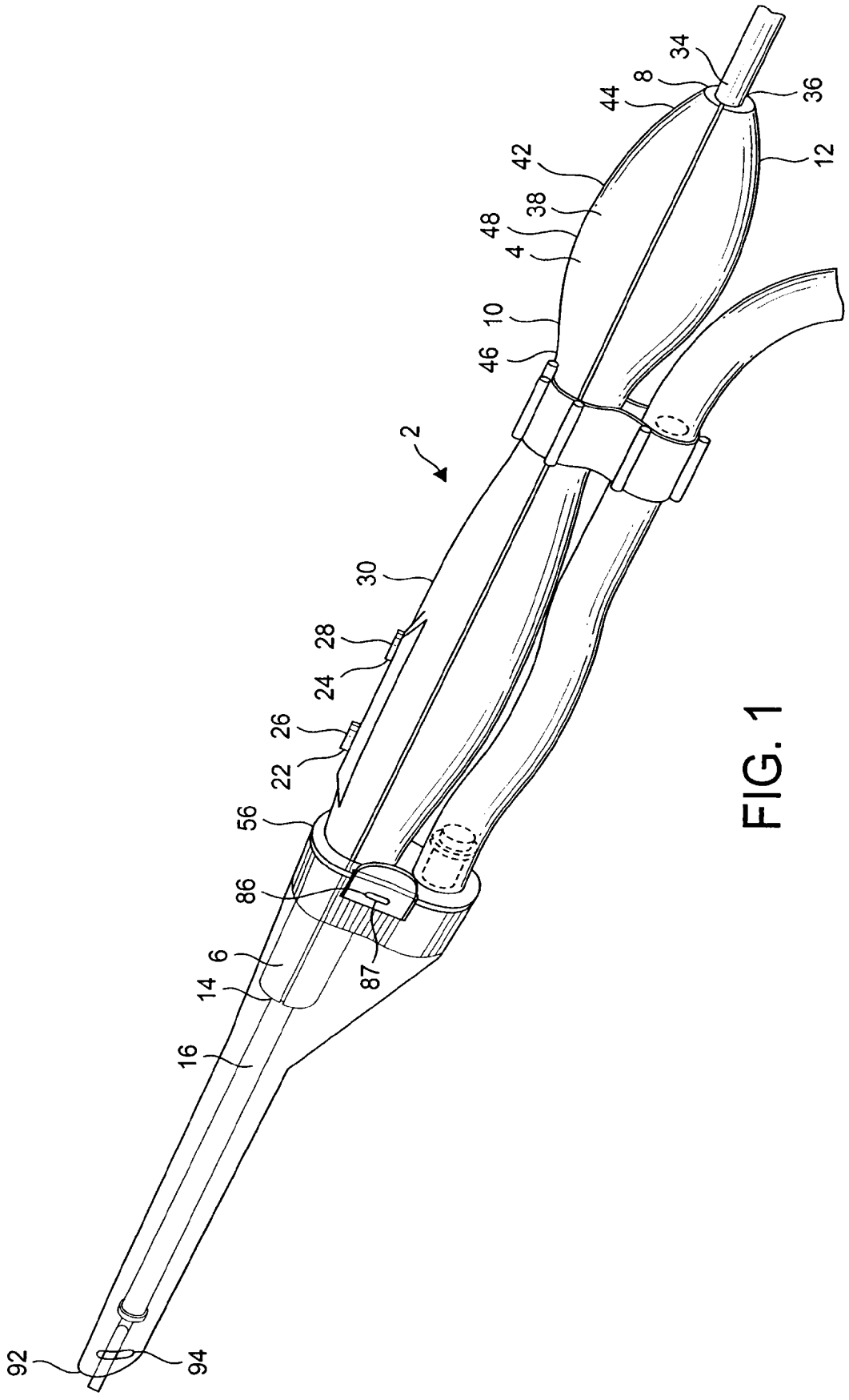

FIG. 1

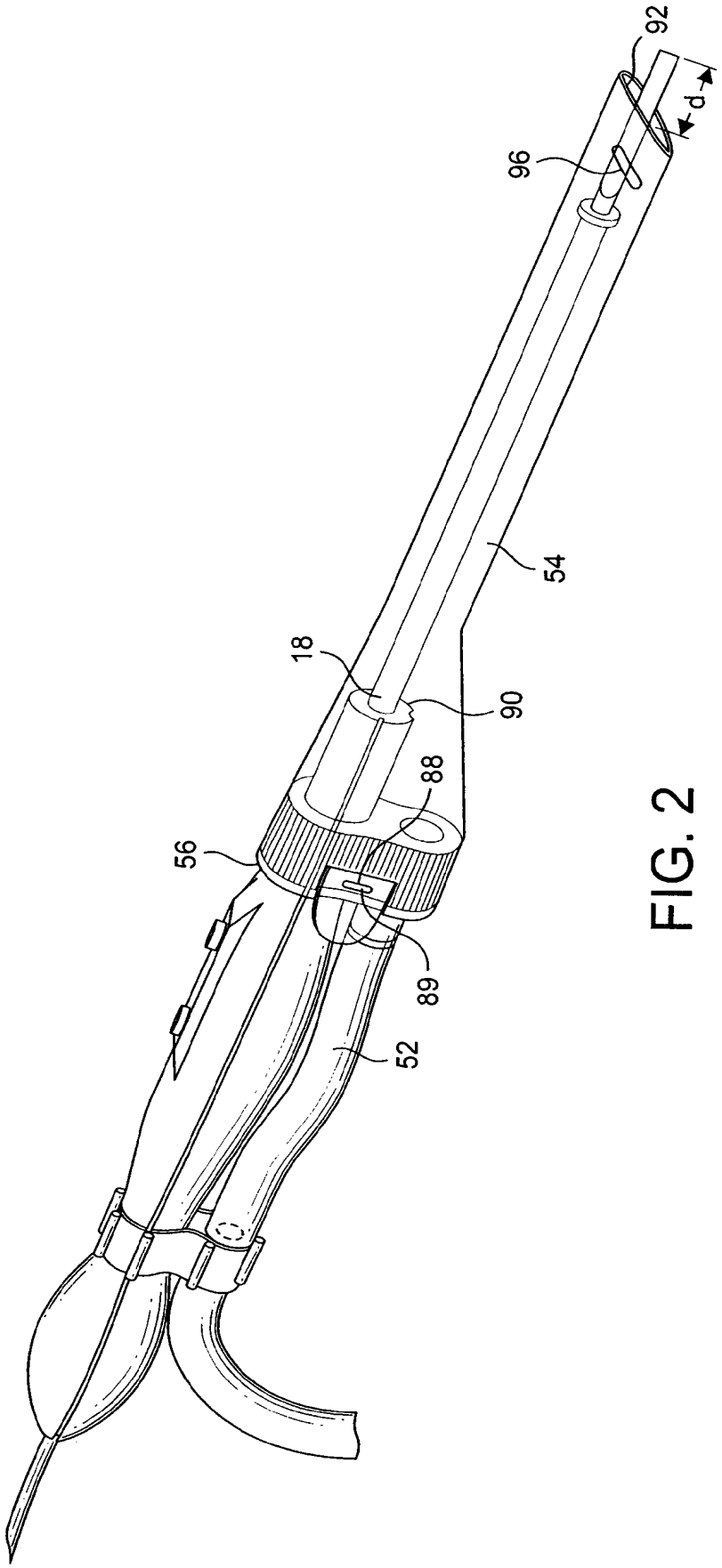

FIG. 2

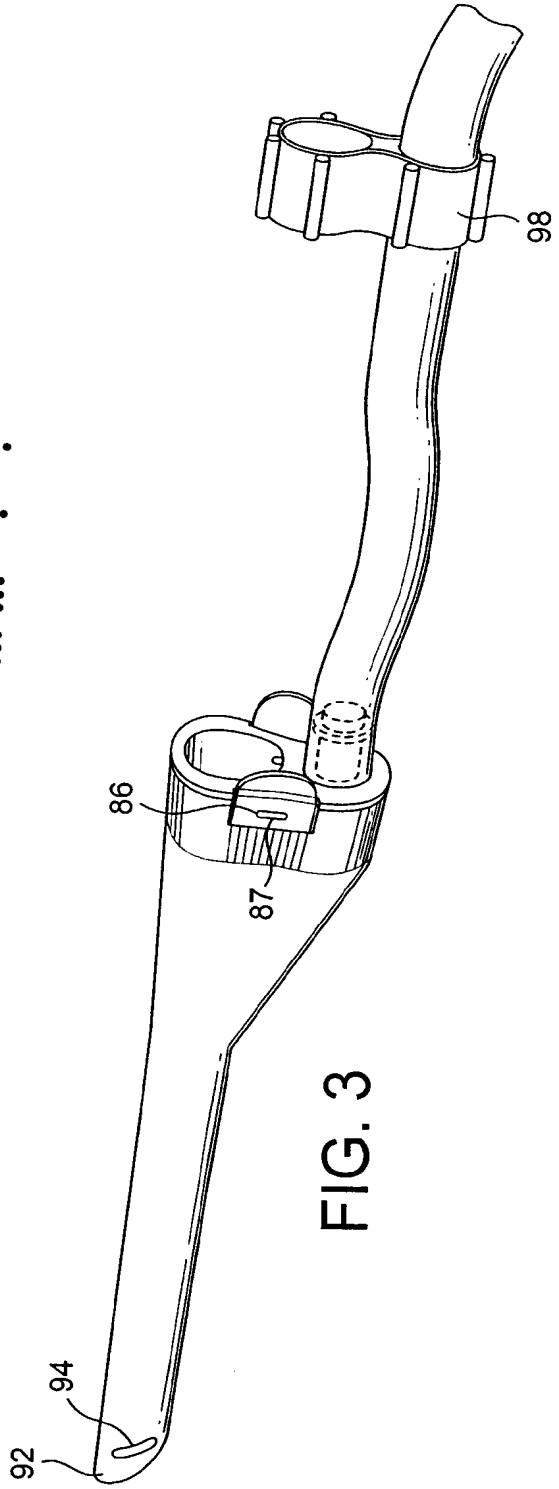
98
86
87
94
92

FIG. 3

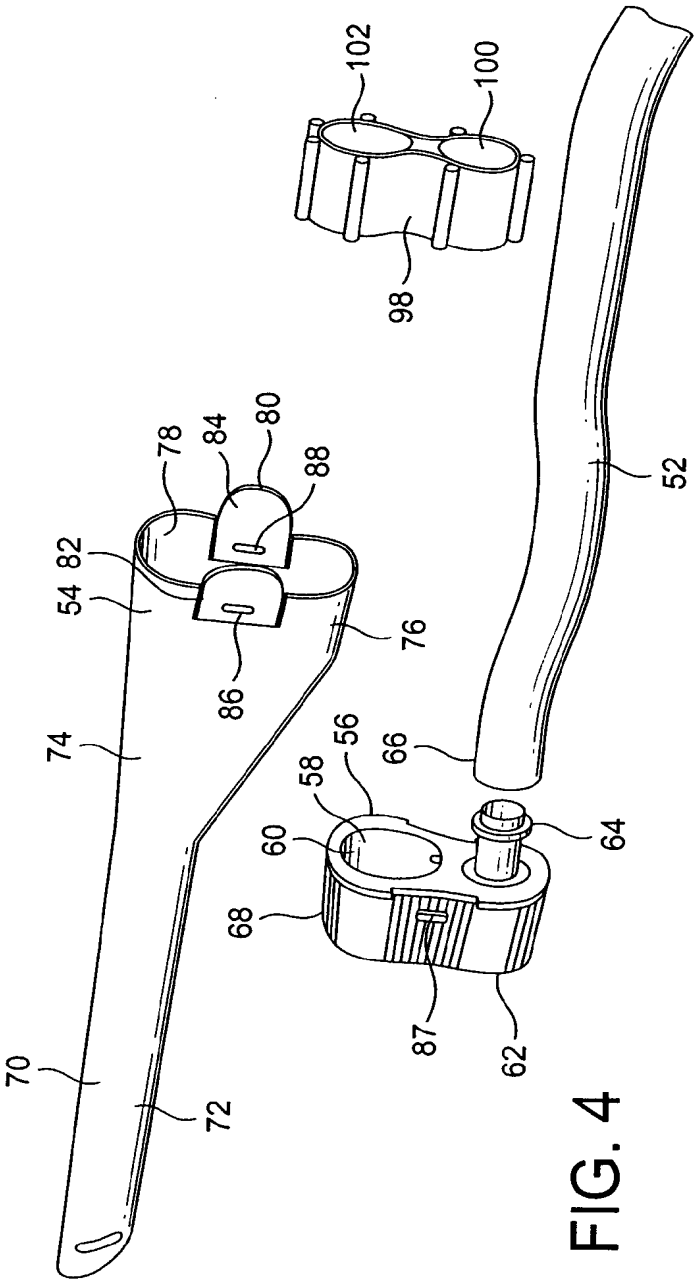
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FIG. 4

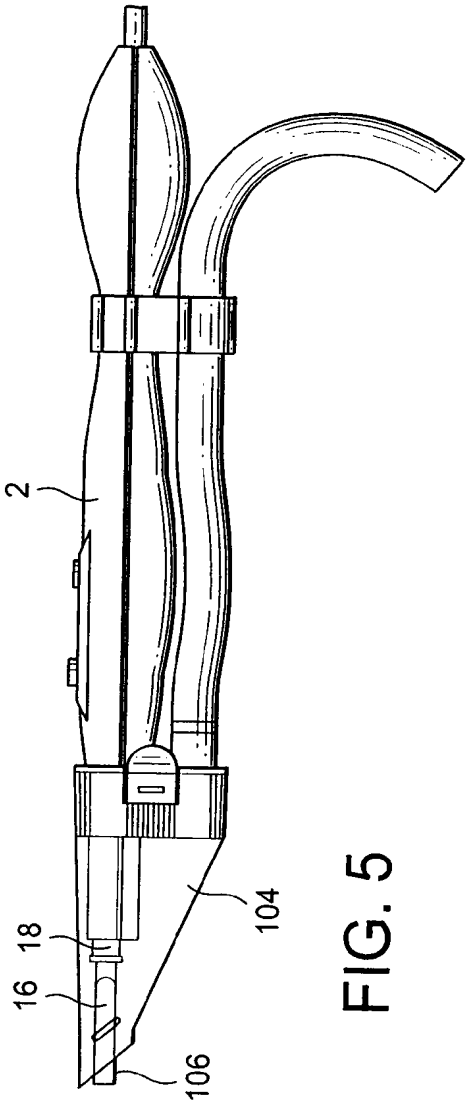


FIG. 5

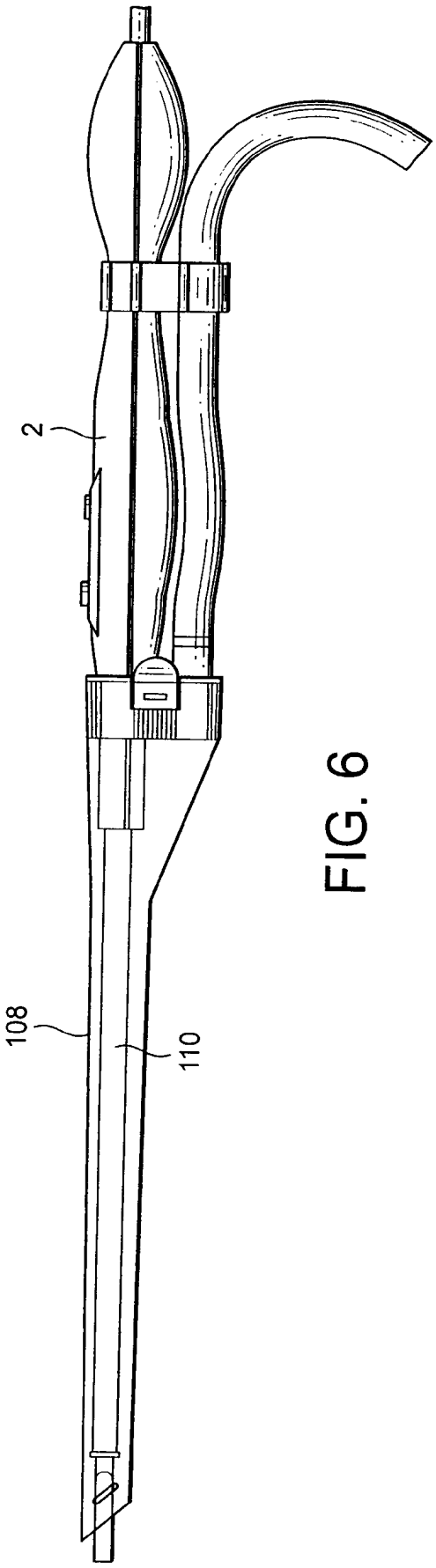


FIG. 6

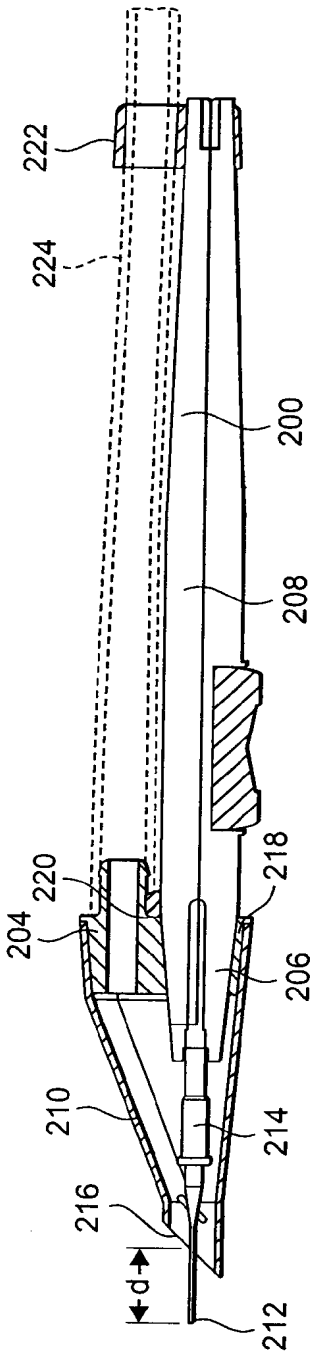


FIG. 7

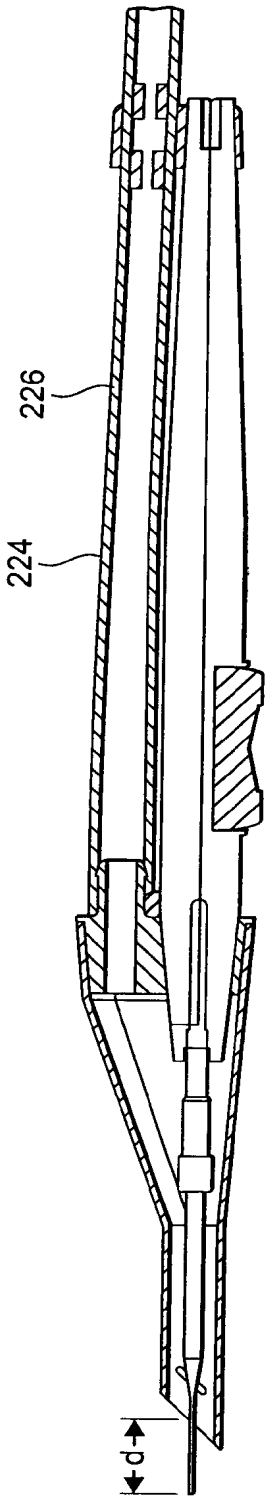


FIG. 8

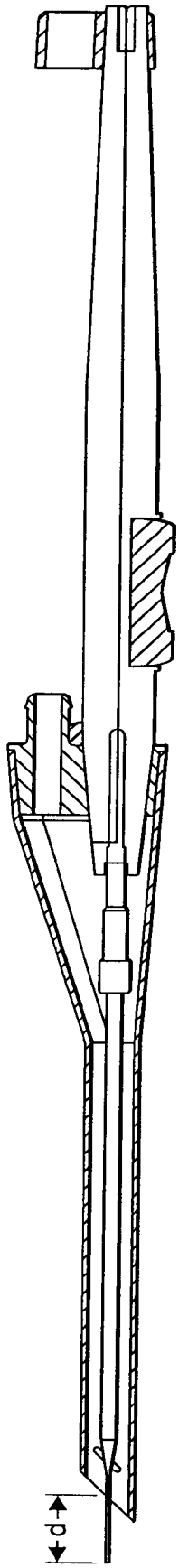
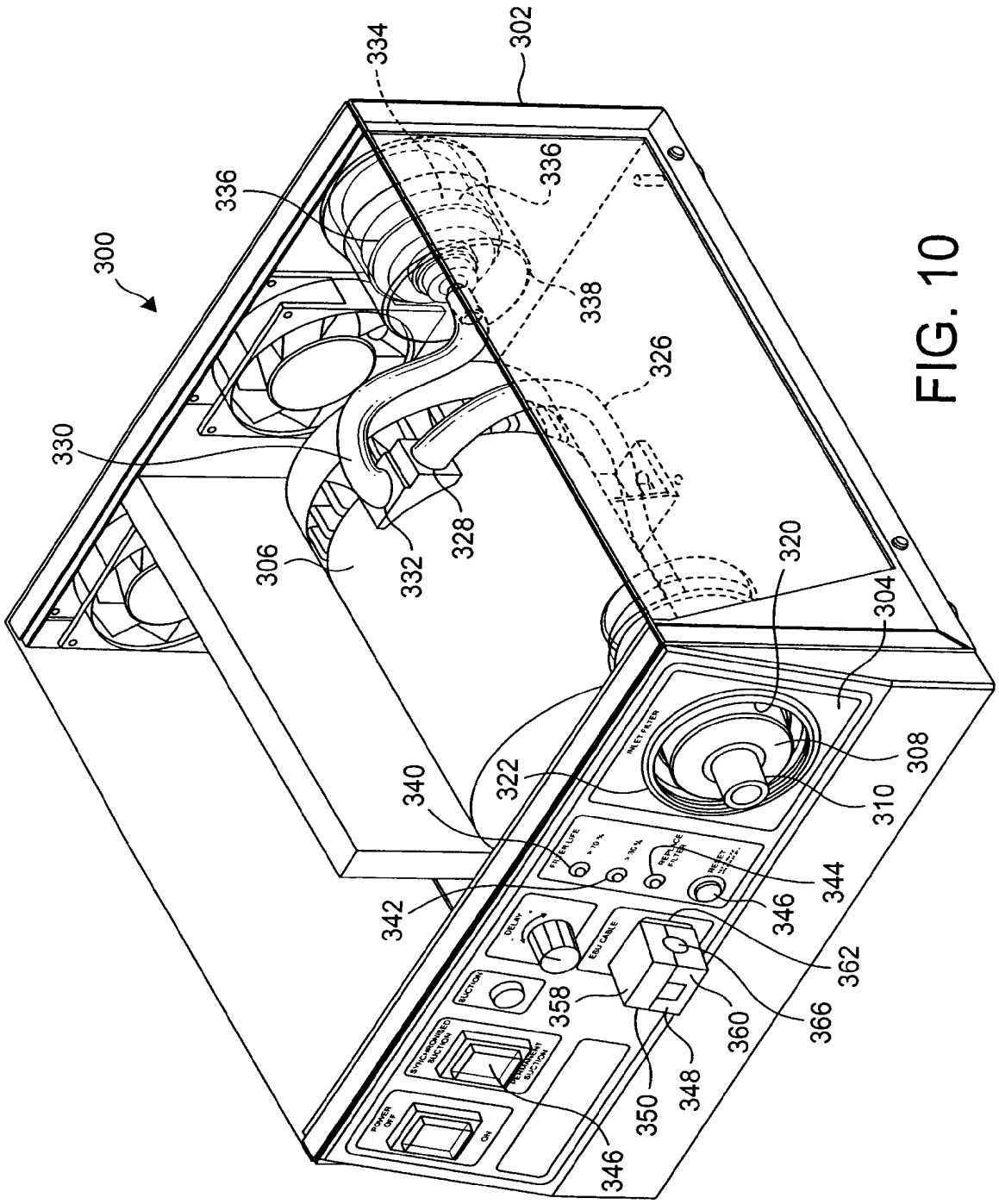


FIG. 9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362
366
INLET FILTER
REPLACE FILTER
RESET
SUCTION
DELAY
EASY CABLE
SYNCHRONIZED SUCTION
CONTINUOUS SUCTION
POWER OFF
ON

FIG. 10

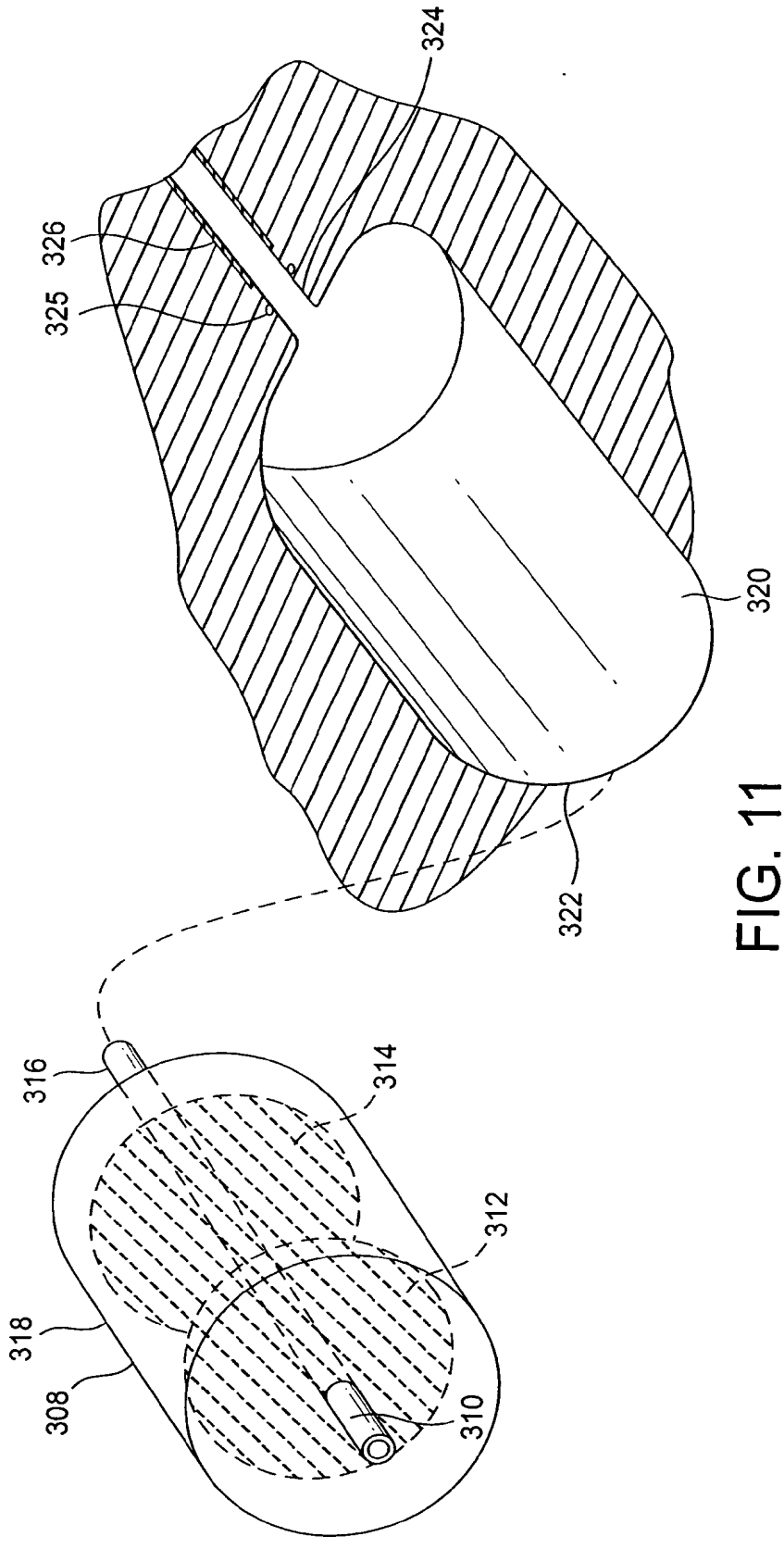

FIG. 11

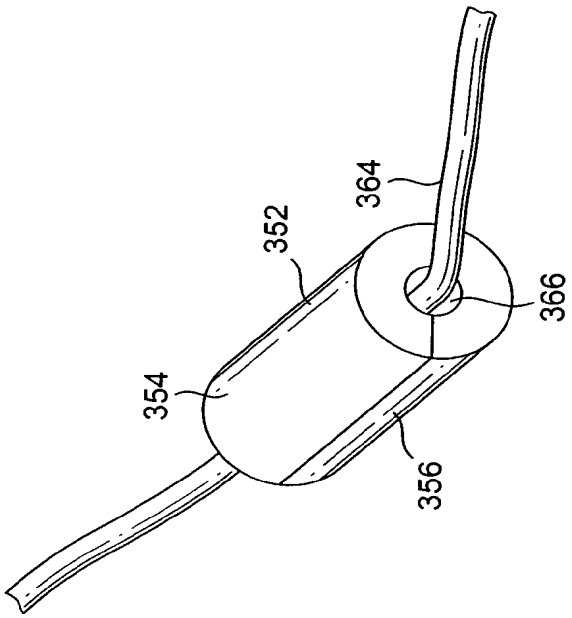

FIG. 13

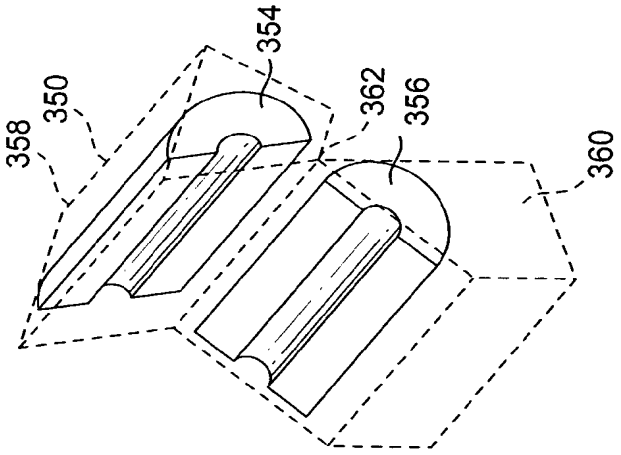

FIG. 12

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ELECTROSURGICAL PENCIL AND SMOKE EVACUATION APPARATUS

The present invention relates to an electrosurgical pencil, to a smoke evacuation shroud for such a pencil, and to a smoke evacuation apparatus for such a pencil.

Electrosurgical pencils are well known in the art and have, at a distal end of the pencil, an electrode (which may be in the form of a blade, a ball or a cutting loop, for example) which may be selectively powered by the operation of switches disposed along an upper edge of the pencil, to operate in a cutting mode or a cauterising mode. Such electrosurgical pencils are known, for example from WO-A-92/22258, WO-A-96/23448, WO-A-97/14364, WO-A-97/16124 and EP-A-0582483.

Some known electrosurgical pencils are provided with an aspirator tube for the purpose of evacuating smoke away from the region of the body of the patient, which is being cut or cauterised by the electrode. The aspirator tube has an open end, which is located generally in the vicinity of the working region of the electrode and is connected at its other end remote from the pencil to a source of suction. A hood or shroud may be provided at the end of the tube to assist effective removal of smoke from the body region being cut or cauterised.

For some electrosurgical pencils, there is a need to have removable electrodes of varying length. There is a need for a smoke evacuation shroud which readily accommodates electrodes of varying length, and can permitting easy attachment and removal of the electrode to the electrosurgical pencil, while still providing good smoke evacuation performance, providing a more versatile arrangement.

It is often important for good smoke evacuation performance for the shroud to be accurately located, longitudinally along the pencil length, relative to the electrode. There is still a need for an electrosurgical pencil having a smoke evacuation device providing improved smoke evacuation performance, particularly for electrodes of varying length.

Some electrosurgical pencils are intended to be reusable (after sterilisation) and some disposable. For such disposable pencils, there is a need for a smoke evacuation device

which can securely and reliably be fitted to a variety of different disposable electrosurgical pencils, which may vary from one another in shape and/or dimensions.

Typically, the aspirator tube is connected to a smoke evacuation apparatus, which incorporates a vacuum pump for applying suction to the tube. A number of such smoke evacuation apparatus are known. These can suffer from a number of problems. For example, the smoke evacuation pump sometimes is switched off and on in response to operation of the pencil by a surgeon. One known device detects the passage of current through a cable supplying electrical power to the electrode by detecting the electromagnetic field around the cable. The cable is secured by wrapping around a ferrite cylinder. This is mechanically inconvenient, and can lead to damage to the cable. There is a need for an improved device for detecting the electromagnetic field around the cable.

The smoke evacuation apparatus also typically includes filters for filtering the smoke particles, body fluids and bacteria from the air of the evacuated smoke. Known filter apparatus suffers from various problems, in particular concerning their mechanical connection to the apparatus, their lifespan being reliably determinable, their performance in effective filtering of the evacuated air, and providing a structure for accommodating the filters which may be readily disinfected. The present invention aims at least partially to overcome or mitigate at least some of these problems.

Accordingly the present invention provides an electrosurgical pencil comprising an elongate body having a distal end and a near end, a mount at the distal end of the body for mounting an electrode whereby the electrode in use extends from the elongate body, electrical wiring disposed within the body and extending out of the near end of the body for connection to a source of electrical power, the electrical wiring being electrically connected to the mount for electrical connection, in use, to the electrode, a smoke evacuation shroud surrounding the electrode and a connector located on the elongate body at a location spaced from the distal end, the shroud being removably connected to the connector and enclosing a part of the distal end of the elongate body which is distal of the connector, and the connector having a connection element for connection to an aspirator tube of a smoke evacuation apparatus.

The present invention also provides a smoke evacuation shroud assembly for an electrosurgical pencil, the smoke evacuation shroud assembly comprising a smoke evacuation shroud for surrounding an electrode of the electrosurgical pencil and a connector for mounting the shroud to an elongate body of the surgical pencil, the connector having a connection element for connection to an aspirator tube of a smoke evacuation apparatus, the shroud being removably connectable to the connector, the shroud comprising an elongate tube having a distal cylinder portion and a near enlarged portion which tapers in increasing width to define at its near end a fitting for releasably fitting the shroud and connector together in a substantially fluid-tight manner, with an inner surface of the fitting mating with an outer surface of the connector, and the connector having an opening into which the elongate body of the electrosurgical pencil can be fitted.

The present invention further provides a smoke evacuation apparatus for an electrosurgical pencil, the apparatus comprising a suction pump, an inlet filter for the suction pump for connection to an aspirator tube of an electrosurgical pencil, the inlet filter being adapted to filter particulate material and liquid from the aspirated air in the aspirator tube, and an outlet filter for the suction pump, the outlet filter being adapted to filter particulate material and odour from the air outputted by the pump.

The present invention yet further provides a smoke evacuation apparatus for an electrosurgical pencil, the apparatus comprising a suction pump for connection to an aspirator tube of an electrosurgical pencil, and a current detector for detecting electrical current in a cable of an electrosurgical pencil and operable to control the operation of the pump, the current detector comprising an annular ferrite body defining a central bore therethrough, and the body being selectively separable into a plurality of portions to open the central bore for placement of the cable therein.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figures 1 and 2 are side perspective views, from opposed sides, of an electrosurgical pencil provided with a smoke evacuation shroud in accordance with a first embodiment of the present invention;

Figure 3 is a perspective side view of the shroud and aspirator tube of the electrosurgical pencil of Figure 1 when disassembled from the pencil;

Figure 4 is a perspective side view of the shroud and aspirator tube of Figure 3 in when further disassembled into its constituent parts;

Figure 5 is a side view of the electrosurgical pencil of Figures 1 and 2 provided with a second smoke evacuation shroud, and a second electrode blade, of different length than for the electrosurgical pencil of Figures 1 and 2;

Figure 6 is a side view of the electrosurgical pencil of Figures 1 and 2 provided with a third smoke evacuation shroud, and a third electrode blade, of different length than for the electrosurgical pencil of Figures 1 and 2;

Figure 7 is a part sectional side view of an electrosurgical pencil provided with a smoke evacuation shroud in accordance with a second embodiment of the present invention;

Figure 8 is a part sectional side view of the electrosurgical pencil of Figure 7 provided with a second smoke evacuation shroud, and a second electrode blade, of different length than for the electrosurgical pencil of Figure 7;

Figure 9 is a part sectional side view of the electrosurgical pencil of Figure 7 provided with a third smoke evacuation shroud, and a third electrode blade, of different length than for the electrosurgical pencil of Figure 7;

Figure 10 is a perspective view, partly in phantom, of a smoke evacuation apparatus in accordance with a further embodiment of the invention;

Figure 11 is a schematic perspective view, partly in phantom and partly in section, of the fitting between the inlet filter and the vacuum pump inlet tube of the apparatus of Figure 10;

Figure 12 is a schematic perspective view of the ferrite body for the current detection device of the apparatus of Figure 10, the current detection device being in an open configuration; and

Figure 13 is a schematic perspective view of the ferrite body for the current detection device of the apparatus of Figure 10, the current detection device being in a closed and operable configuration.

Referring to Figures 1 to 4 of the drawings, an electrosurgical pencil, designated generally as 2, includes a housing 4 defining an elongate body of the electrosurgical pencil having a distal end 6 and a near end 8. The housing 4 typically comprises moulded plastics material and is divided into an upper housing half 10 and a lower housing half 12 which are fixed together to form the unitary housing 4. A mount 14 for an electrode blade 16 is provided at the distal end 6 of the housing 4. Although a blade is illustrated, in this invention the electrode may have another shape, such as a ball or a loop, as is known in the art. The mount 14 comprises a cylindrical recess into which a cylindrical end 18 of the electrode blade 16 may be inserted. In this configuration, the electrode blade 16 extends axially along the electrosurgical pencil 2, coaxial with a longitudinal axis of the housing 4. Electrical wiring (not shown) disposed within the housing 4 connects the mount 14 and thereby, in use, the electrode blade 16, to a pair of finger-operated switches 22,24. The switches 22,24 are mounted in the housing 4 at a position between the distal end 6 and the near end 8, and each switch 22,24 has a finger-engageable switch surface 26,28 which extends outwardly from the housing 4. The finger-engageable surfaces 26,28 can selectively be pushed by the forefinger of a surgeon in order to operate the respective switch 22,24. These two switches 22,24 extend from a surface region 30 of the upper half 10 of the housing 4 and are longitudinally spaced along the housing 4. In the illustrated embodiment, the switch 22 comprises a cutting switch and the switch 24 comprises a cauterising switch. Electrical wiring (not shown) connects the switches 22,24 to an

external cable 34 which, in use, is connected to a source of electrical power and extends from an axial opening 36 at the near end 8 of the housing 4.

A counterbalance weight (not shown) is disposed in the housing 4 at the near end 8 of the housing 4. In particular, the counterbalance weight is disposed in the upper half 10 of the housing 4. The portion 38 of the housing 4 which is shaped to accommodate the counterbalance weight is shaped radially outwardly at the location of the counterbalance weight and surrounds the counterbalance weight so as to provide an enlarged diameter portion 42 at the near end 8 of the elongate body. The enlarged diameter portion 42 is smoothly curved, for both the upper 10 and lower 12 halves of the housing 4, providing a progressively increased diameter from each of two opposed edges 44, 46 thereof, defining near and distal edges 44,46 of the enlarged diameter portion 42, to a centre part 48 of the enlarged diameter portion 42. This provides that the surface of the enlarged diameter portion 42 between the distal edge 46 and the centre part 48 is shaped comfortably to rest upon and engage a surgeon's hand between the thumb and forefinger thereof.

The enlarged diameter portion 42 containing the counterbalance weight, and the switches 22, 24 are longitudinally spaced along the housing 4 by such a distance so that when the enlarged diameter portion 42 rests on the surgeon's hand, the forefinger of the surgeon's hand can readily selectively engage the switches 22, 24. The counterbalance weight is selected to have a mass and a position within the housing 4 so that the electrosurgical pencil as a whole has a centre of gravity, along its length, which is located between the location of the switches 22, 24 (where the surgeon's fingers hold the pencil) and the location of the counterbalance weight. In this way, the counterbalance ensures that the weight of the electrosurgical pencil balances across the hand of the surgeon, thereby lifting the region 30 of the electrosurgical pencil upwardly at the location of the thumb and middle finger of the user so that minimal manual pressure is required by the surgeon to support the electrosurgical pencil.

The counterbalance weight also provides that the forefinger of the user is merely required to operate the switches 24, 22 and is not required to exert a downwardly directed force on the electrosurgical pencil to hold the pencil in the correct orientation. In combination, these effects reduce the amount of fatigue caused when the electrosurgical pencil is held

by a surgeon during surgical operations. This tends to reduce the problem of cramp which is known to be encountered with known electrosurgical devices.

The electrosurgical pencil 2 is also provided with an aspirator tube 52 and a smoke evacuation shroud 54 connected thereto both of which are removably mounted on the housing 4. The aspirator tube 52 and the shroud 54 may be disposable, whereas the remainder of the electrosurgical pencil 2 may be reusable. The aspirator tube 52 is mounted on the housing 4 so as to extend along an axis located on a lower side of the housing 4 defined by the lower half 12, with the axis being parallel to the longitudinal axis of the electrosurgical pencil 2 and of the electrode blade 16. The aspirator tube 52 typically comprises a transparent plastics material which can be flexed. The shroud 54 is typically composed of a transparent plastics material, for example an injection moulding.

A connector 56, typically of injection molded plastics material, is fitted around the housing 4 at a location rearwardly of the electrode blade 16 and of the distal end of the housing 4. The connector 56 may be reusable or disposable. The connector 56 has a first substantially circular opening 58, which typically is slightly tapered (the diameter decreasing in a distal direction) on its inner surface 60, to enable the connector 56 to be push fitted (from a distal direction) over the housing 4 in a secure fluid-tight manner. The connector 56 is also provided with a second substantially circular opening 62, parallel to the first opening 58, which is provided on its near side with a connecting element 64, for example a push-fit connecting element 64, for connecting securely in a fluid-tight manner with an end 66 of the aspirator tube 52. The connector 56 has a substantially elliptical outer surface 68 which is shaped to mate with an inner surface of the shroud 54, to form a fluid-tight connection therebetween.

The smoke evacuation shroud 54 comprises an elongate tube 70 having a distal cylinder portion 72, with a substantially circular cross-section, and a near enlarged portion 74, which tapers in increasing width to define at its near end a fitting 76 so that the smoke evacuation shroud 54 may be selectively fitted to the connector 56. The smoke evacuation shroud 54 constitutes a female element into which the connector 56 is fitted as a male element so that the shroud 54 and connector 56 are fitted together in a fluid-tight manner, with the inner surface 78 of the fitting 76 mating with the outer surface 68 of the connector

56. A releasable snap-fitment 80 is provided between the shroud 54 and the connector 56 to enable the shroud 54 to be securely clipped onto the connector 56, but readily releasable when required. In the illustrated embodiment, the snap-fitment 80 comprises a pair of wing members 82,84 on opposed sides of the fitting 76 of the smoke evacuation shroud 54, each wing member 82, 84 provided with a cavity 86, 88 therein. The wing members 82, 84 are flexible so as to be able to be secured by way of a relaxation fit over the connector 56, with opposed projections 87, 89 on the connector 56 each snap-fitting into a respective cavity 86, 88in a respective wing member 82, 84. The shroud 54 can readily be disassembled from the connector 56 by flexing the wing members 82, 84 outwardly thereby to release the snap-fitment 80.

The near end of the shroud 54 defines, together with the connector 56, a manifold for suction so that the suction is applied from the aspirator tube 52 to a volume surrounding both the electrode blade 16 and a portion of the housing 4 adjacent to the distal end 90 of the electrosurgical pencil 2. This provides effective evacuation of smoke and other debris away from the patient's body and from the electrosurgical pencil 2.

At the extreme distal end 92 of the shroud 54, the annular end surface 94 is inclined to the longitudinal axis of the blade 16 and the shroud 54. The length of the shroud 54 is selected so that the blade 16 projects slightly from the end 92 of the shroud 54. The projection distance, indicated as "d", has been found by the inventors to be very important for ensuring effective smoke evacuation, and so it must be predetermined to a single value or within a narrow range for reliable and effective operation of the shroud 54. Accordingly, by ensuring a secure fitment, at a specific longitudinal position, of the shroud 54 to the connector 56, and by corresponding secure fitment of the connector 56 at a particular longitudinal position along the housing 12 of the electrosurgical pencil 2, the projection distance "d" of the electrode blade 16 from the shroud 54 can be precisely defined and reliably maintained during a surgical procedure.

On opposed sides of the distal end 92 of the shroud 54, a pair of vent holes 94, 96 are provided to prevent an excessive suction force being applied against the body of a patient. Each vent hole 94, 96 consists of a slit which is inclined to the common longitudinal axis of the shroud 54 and the electrode blade 16.

The aspirator tube 52 is fitted to a middle portion of the housing of the electrosurgical pencil 2 by a securing clip 98. In the illustrated embodiment, the securing clip 98 is located at a middle portion of the housing and distal of the counterweight, but in other embodiments the securing clip 98 may be located on the near side of the counterweight, i.e. near to or at the near end 8 of the housing 12, as this would reduce interference with the surgeon's hand. The securing clip 98 may be reusable or disposable. The securing clip 98 has a first tubular portion 100 which surrounds and securely holds the aspirator tube 52 and a second part-circular portion 102, integral therewith, which snap fits over the housing 12 of the electrosurgical pencil 2. The clip 98 can be released from the pencil 2 when required by releasing the snap fitting. The clip 98 may be made of an injection molded plastics material.

As shown in Figures 1 to 4, the electrosurgical pencil 2 comprises a reusable body together with a removable electrode blade 16, which may be reusable or disposable, a removable shroud 54, which may be reusable or disposable, and a removable aspirator tube 52, which may be reusable or disposable. Typically, the blade 16, the shroud 54 and the tube 52 are disposable. For many surgical procedures, it is necessary for the surgeon to employ an electrosurgical pencil 2 having varying electrode blade lengths. Accordingly, as shown in Figures 5 and 6, the same electrosurgical pencil 2 may be provided with alternative sets of shroud/electrode blade combinations, of varying length, so that the single electrosurgical pencil 2 can be employed using different electrode blade lengths, yet with consistently reliable and smoke evacuation for the respective electrode blades.

Thus in Figure 5 the electrosurgical pencil 2 is provided with a short, shroud 104/electrode blade 106 combination, and in Figure 6 the electrosurgical pencil 2 is provided with a long shroud 108/electrode blade 110 combination, in contrast to the medium length shroud 54/electrode blade 16 combination shown in Figures 1 to 4.

As described above, the connector 56 is securely fitted at a particular longitudinal position along the housing 12 of the electrosurgical pencil 2. The shrouds 54, 104, 108 can readily be interchanged by removal of one shroud from the connector 56 and snap fitting of

another shroud to the same connector 56 without interfering with the aspirator tube 52 or its connection to the connector 56. This is convenient for the surgeon. Moreover, the interchange of shrouds and electrode blades ensures that the length of the portion of the electrode blade that projects from its associated shroud is maintained at the critical distance "d", as a result of the secure fitting of the connector 56 to the housing 12 of the electrosurgical pencil 2, and the secure fitting of the shroud 54, 104, 108 to the connector 56.

In the illustrated embodiment, the connector 56 is removably fitted to the electrosurgical pencil 2, by a push fit. In order to ensure reliable positioning of the connector 56 in a particular longitudinal position with respect to the housing 2 of the electrosurgical pencil 2, the shape and dimensions, and material properties, of the inner surface 60 of the opening 58 of the connector 56 are controlled so as to provide a substantially secure air- and liquid-tight fit between the female/male connection of the connector 56 and the housing 12 of the electrosurgical pencil 2 at a particular longitudinal position along the length of the electrosurgical pencil 2. The inner surface 60 of the opening 58 may be substantially rigid and shaped so as precisely to mate with a corresponding substantially rigid outer surface of the housing 12 of the electrosurgical pencil 2, optionally with a sealing surface or seal member (not shown) being provided to ensure a fluid-tight fit. Alternatively, the opening 60 may be provided with a flexible and deformable inner surface 60, which on application of a sufficient push fitting force, can be conformed to the shape and dimensions of the outer surface of the housing 12 of the electrosurgical pencil 2, yet be securely fitted thereto at a particular longitudinal location so as not readily to be movable from that location.

In alternative embodiments of the present invention, the connector 56 is securely and permanently bonded to the housing 12 of the electrosurgical pencil 2, or has been integrally formed together with the housing 12 of the electrosurgical pencil 2, so as to be part of the housing 12. For these embodiments, the longitudinal position of the connector 56 is permanently fixed in a preset position relative to the housing 12 of the electrosurgical pencil 2 as a result of the bonding or the integral molding, but this still provides ready fitting of shrouds of differing length to the electrosurgical pencil 2.

A set of shrouds of differing length may be provided, with or without a corresponding set of electrode blades of differing length, either separate from or in combination with the electrosurgical pencil.

A further embodiment, incorporating a common electrosurgical pencil with shrouds and corresponding electrode blades of differing lengths, is shown in Figures 7 to 9.

In this embodiment, the electrosurgical pencil 200 is intended to be disposable. A connector 204 is fitted over the distal end 206 of the housing 208 of the electrosurgical pencil 200 in a manner substantially similar to that described hereinabove for the embodiment of Figures 1 to 4. In the earlier embodiment, the shroud 54 and connector 56 were of a design dedicated to fit to a specific electrosurgical pencil. In contrast, in this embodiment, the smoke evacuation shroud 210 is configured so that it may be fitted to a variety of different electrosurgical pencils 200 from different manufacturers, as a retrofit, and yet still reliably achieve accurate spacing of the end 212 of the electrode blade 214 from the distal end 216 of the smoke evacuation shroud 210, irrespective of minor variations in the shape and dimensions of the particular electrosurgical pencil 200 to which the smoke evacuation shroud 210 has been fitted.

Thus in this embodiment, the connector 204 is provided with a conformable material 218, typically of plastics and/or rubber, in the opening 220 into which the particular electrosurgical pencil 200 is fitted. This provides that when the connector 204 is push fitted onto the distal end 206 of the housing 208 of the electrosurgical pencil 200, the connector 204 can be pushed fitted so as accurately to be located at the required longitudinal position, and at that position securely hold the connector 204 on the housing 208 in a fluid-tight manner. This is achieved by conforming the conformable material 218 to fit the external shape of the housing 208 of the electrosurgical pencil 200. The connector 204 is slid up the housing 208 and manipulated manually until it is located at the correct position, whereafter upon release the conformable material 218 safely holds the connector 204 in the same position during use of the electrosurgical pencil 200 by the surgeon.

As shown in each of Figures 7 to 9, a securing clip 222 is provided remote from the location of the shroud 210 for securing the aspirator tube 224 to a part of the housing 208 of the electrosurgical pencil 200 remote from the distal end 206 of the electrosurgical pencil 200.

Referring to Figure 8 (for example), in order to assist the reliable fitting, at a particular longitudinal position, of the shroud 210 relative to the electrosurgical pencil 200, there are provided a biasing means for applying a pulling force on the connector 204, and thereby the shroud 210 attached thereto, for pulling the connector 204 and the shroud 210 rearwardly onto the electrosurgical pencil 200, thereby to ensure a secure fitment therebetween at the selected longitudinal position.

In accordance with this aspect, the aspirator tube 224 may wholly or partly comprise an elastic material, for example an elastomeric material, which applies a rearward pulling force on the connector 204. In the particularly preferred embodiment, the aspirator tube 224 includes a segment 226 of elastomeric material, for example silicone rubber, which acts as a biasing means for pulling the connector 204 and thereby the shroud 210 onto the electrosurgical pencil 200. Other elastomeric materials may be employed. The segment 226 may be fitted between the connector 204 and the clip 222. The segment 226 may additionally or alternatively be shaped, for example by corrugation, to provide a spring-like bias. This corrugation is provided either in the entire tubular segment 226, or alternatively the segment 226 may comprise a corrugated outer tubular part surrounding an inner non-corrugated part, so that the entire tubular assembly of the segment 226 can be biased to provide a tensioning force therealong.

The conformable material 218 may in addition provide a tactile and/or frictional coating between the interior of the connector 204 and the exterior of the housing 208 of the electrosurgical pencil 200. Such a coating may be provided on the exterior surface of the housing 208 of the electrosurgical pencil 200, and/or on the interior surface of the connector 204. Furthermore, either or both of the interior surface of the shroud 210 and the exterior surface of the connector 204 may be provided with a tactile and/or frictional coating, for connecting the shroud 210 to the connector 204. Furthermore, a ratchet or

relaxation snap fitting may additionally be provided for connecting the shroud 210 to the connector 204 in a secure manner.

As for the first embodiment, a set of shrouds of differing length may be provided, with or without a corresponding set of electrode blades of differing length, either separate from or in combination with the electrosurgical pencil.

In the illustrated embodiments, a single aspirator tube is provided which is connected via a manifold to the smoke evacuation shroud which surrounds the electrode blade and the end of the electrosurgical pencil. However, in further modifications of the invention at least two aspirator tubes may be provided which are connected to the manifold, one being arranged or adapted for aspirating smoke, and another being arranged or adapted for aspirating human debris and bodily fluids from the patient's body. In particular, the electrosurgical pencil may be provided with two tubes, one intended for smoke and the other intended for human debris and bodily fluids, each connected to a respective suction apparatus, or connected to a common suction apparatus by a manifold which may be switchable between the two tubes. The tubes may be adjacent or one may surround the other. One or both tubes could be mechanically advanceable by the surgeon using an actuator or slider mechanism, which optionally could operate an automatic actuation for the suction to be applied to the respective tube. The surgeon could selectively switch the suction on for one or both tubes, so as to have either or both operating at a given time.

In accordance with another aspect of the invention there is provided a smoke evacuation apparatus which is connected to the aspirator tube and applies suction (a negative pressure) to the tube to remove smoke, human debris and bodily fluids form the patient's body.

Referring to Figures 10 to 13, the smoke evacuation apparatus 300 comprises a casing 302 with a control panel 304. The casing 302 conceals a suction or vacuum pump 306, the pump typically being a rotary vane pump, for applying suction to the aspirator tube when fitted to the smoke evacuation apparatus 300. An inlet filter 308 is provided, with a tubular inlet 310 onto which the aspirator tube is press fitted.

The inlet filter 308 comprises, in combination, a first upstream filter 312 and a second downstream filter 314. The upstream filter 312 comprises a HEPA filter, for example of paper with very fine pores, which is for filtering particulate material, including smoke particles and biological material, and also bacteria, from the air. The downstream filter 314 comprises a hydrophobic filter which prevents any liquid passing therethrough, thereby to prevent any liquid or bodily fluids from entering the pump 306. On a downstream side of the inlet filter 308, a tubular outlet 316 is provided. The inlet filter 308 comprises the filter elements of the upstream and downstream filters 312, 314 mounted in a serial fashion and surrounded by an exterior housing 318. The exterior housing 318 of the inlet filter 308 comprises a cup or cylinder, which together with its internal filter assembly can be readily replaced and disposed of. The apparatus is provided with a correspondingly shaped cavity 320 which opens onto the front face 322 of the control panel 304 of the apparatus 302 so that the exterior housing 318 of the inlet filter 308 may readily be inserted into the cavity 320 and removed when necessary.

The cavity 320 is provided with a tubular outlet 324 having an O-ring 325 on its internal surface for receiving and sealing the tubular outlet 316 of the inlet filter 308. Preferably, both the inner surface of the cavity 320 and the outer surface of the exterior housing 318 are smooth and absent any surface texture which could harbour bacteria, so that they can readily be cleaned so as to reduce the possibility of bacterial infections. This structure enhances infection control. The inlet filter 308 can be readily pulled out from the cavity 320 for inspection and for ready cleaning of the interior surface of the cavity 320, which is preferably sufficiently large to enable ready manual cleaning.

A disposable cup (not shown), having an exterior surface that mates with the interior surface of the cavity 320, and opening out at the front of the control panel 304, may be provided as an alternative or in addition to the exterior housing 318 of the inlet filter 308. The cup can act as an additional barrier against contamination of the smoke evacuation apparatus. This facilitates infection control, because after each use, or periodically, the cup can be disposed of, even without disposal of the inlet filter 308, or one or both of its constituent parts, namely the upstream and downstream filters 312,314.

The tubular outlet 324 is connected by a flexible tube 326 which connects to an inlet 328 of the pump 306. A further flexible tube 330 passes from the outlet 332 of the pump 306 to an outlet filter 334. This comprises a carbon filter 336 for removing odour from the aspirated air and also particulate material which may have inadvertently been derived from moving parts of the pump 206. As for the inlet filter 208, the outlet filter 334 includes an exterior housing 336 which is removably press fitted into a cavity 338, with a tubular inlet for the outlet filter 334 sealingly fitting into a tubular inlet of the cavity 338. Both the exterior housing and the cavity are smooth so that they can readily be cleaned. If desired, a disposable cup, lining the cavity 338, may be provided in a similar manner to the disposable cup for the inlet filter.

The provision of both inlet and outlet filters, on respective upstream and downstream sides of the pump, provides the advantage that the inlet filter, which tends to be replaced more frequently, has lower consumable costs, because the carbon fiber does not need to be replaced quite so often, and also the provision of the downstream filter ensures that odour and particles are not inadvertently introduced into the operating theatre. Each of the inlet and outlet filters can readily be pulled out of the respective cavity and inspected. However, during use the filters are securely nested inside the respective cavity. Again, this assists infection control.

The control panel 304 is provided with a filter life indicator in the form of a set of light emitting diodes coloured to represent a set of traffic lights. A green LED 340 indicates greater than 70% filter life left, an orange or yellow LED 342 indicates greater than 30% filter life left, and a red LED 344 indicates that the filters require replacement. It should be clear that other fractions of the filter lifetime may be indicated. The filter lifetimes and their fractions may be adjustable. The skilled person will appreciate that one or more other types of display device, instead of LEDs, may be employed to display the lifetime of the filter. A reset button 346 is provided to reset the filter life measuring circuit. The filter life measuring circuit acts to measure operation time, and has been preset based on the lifetime of the particular filters employed. The filter life measuring circuit may incorporate a pressure monitor in the inlet filter. When the pressure monitor measures (in real time) a particular pressure drop across the inlet filter, which may be an indication of

filter blockage, this automatically triggers illumination of the red LED for indicating immediate replacement of the inlet filter.

A button 346 on the control panel 304 is provided to select between permanent suction (the pump 306 is permanently working when the apparatus is switched ON) and synchronised suction (the pump 306 is only working when required by the surgeon when the apparatus is switched ON). The synchronised suction mode works by automatic detection (with or without a delay when starting or stopping, which may be set by the control panel) of operational parameters indicating that suction is required There are three particular synchronisation modes that the apparatus may employ to activate the smoke evacuation by operating the pump 306-

1. Current may be detected passing through the active cable which provides electrical power to the electrosurgical pencil. Activation of the finger switch on the pencil then triggers the apparatus to start smoke evacuation by the pump.

2. An additional cable can be used to connect the electrosurgery unit to the smoke evacuation apparatus (for example the rear panel of the casing). Again, activating the fingerswitch will activate the pump 306 to commence smoke evacuation.

3. The pump 306 in the apparatus can be controlled via a footswitch (not shown) connected to the smoke evacuation apparatus (for example the rear panel of the casing).

For implementing the first synchronisation mode, requiring the detection of electrical current in the cable feeding electrical power to the electrosurgical pencil, the control panel 304 is also provided with a current detector 348 for detecting electrical current in the cable. The current detector 348 comprises a housing 350 for an annular ferrite tube 352 which is longitudinally split into two halves 354, 356. The housing 350 can be opened by raising and rotating a corresponding top housing half 358 relative to a bottom housing half 360 about a hinge 362. This separates the halves 354, 356 of the ferrite tubes as shown in Figure 13, readily permitting the cable 364 of the electrosurgical pencil to be disposed in the central cylindrical bore 366. The housing 350 is then closed, closing the ferrite tube 352 with the cable 364 therein, as shown in Figure 14. A locking mechanism 368 is provided to keep the housing 350 shut. The housing 350 also holds a coil (not shown). When current passes through the cable 364, the resultant electromagnetic field is detected by the ferrite tube 352/coil leading to detection by the apparatus of current passing to the

electrosurgical pencil. This turns on the pump for the aspirator tube, in synchronism (with or without a delay) with the current flow.

This mechanical arrangement of the current detector is very convenient to use by a surgical team and ensures reliable current detection. Also, as compared to a known device which wraps the cable about a core and then traps the cable, this reduces the possibility of damage to the cable during use.

In a particular embodiment, the smoke evacuation apparatus and the electrosurgery apparatus for providing power to and controlling the electrosurgery pencil are electrically connected together, for example by a plug connector. When the electrosurgery apparatus is switched on, this can switch on the smoke evacuation apparatus automatically. When the electrosurgical pencil is switched on, and/or there is a demand by the surgeon for smoke evacuation, for example by operating the pencil or by switching a dedicated switch, the electrosurgery apparatus automatically switches on the smoke evacuation.

CLAIMS:

1. An electrosurgical pencil comprising an elongate body having a distal end and a near end, a mount at the distal end of the body for mounting an electrode whereby the electrode in use extends from the elongate body, electrical wiring disposed within the body and extending out of the near end of the body for connection to a source of electrical power, the electrical wiring being electrically connected to the mount for electrical connection, in use, to the electrode, a smoke evacuation shroud surrounding the electrode and a connector located on the elongate body at a location spaced from the distal end, the shroud being removably connected to the connector and enclosing a part of the distal end of the elongate body which is distal of the connector, and the connector having a connection element for connection to an aspirator tube of a smoke evacuation apparatus.

2. An electrosurgical pencil according to claim 1, wherein the connector has a first substantially circular opening on its near surface, which enables the connector to be push fitted over the elongate body of the electrosurgical pencil in a fluid-tight manner, and a second substantially circular opening which is provided on its near side with the connecting element for connecting with an aspirator tube in a fluid-tight manner.

3. An electrosurgical pencil according to claim 2, wherein the first substantially circular opening has an inner surface which is rigid and shaped and capable of mating with the outer surface of the elongate body in a fluid-tight manner.

4. An electrosurgical pencil according to claim 2, wherein the first substantially circular opening has an inner surface which is flexible and deformable and is capable of being conformed to the shape and dimensions of the outer surface of the elongate body to provide a fluid-tight fitting between the elongate body and the connector.

5. An electrosurgical pencil according to any preceding claim, which further comprises a biasing means for applying a pulling force on the connector, and thereby the shroud attached thereto, for pulling the connector and the shroud rearwardly relative to the electrosurgical pencil.

6. An electrosurgical pencil according to claim 5, further comprising an aspirator tube connected to the connector element which wholly or partly comprises an elastic material, the elastic material comprising the biasing means.

7. An electrosurgical pencil according to any preceding claim wherein the shroud comprises an elongate tube having a distal cylinder portion and a near enlarged portion which tapers in increasing width to define at its near end a fitting for releasably fitting the shroud and connector together in a substantially fluid-tight manner, with an inner surface of the fitting mating with an outer surface of the connector.

8. An electrosurgical pencil according to claim 7, wherein a releasable snap-fitment is provided between the shroud and the connector.

9. An electrosurgical pencil according to claim 7 or claim 8, wherein the extreme distal end of the shroud comprises an annular end surface which is inclined to the longitudinal axis of the electrode and the shroud.

10. An electrosurgical pencil according to any one of claims 7 to 9, wherein the electrode projects from the end of the shroud by a projection distance predetermined to ensure effective smoke evacuation.

11. An electrosurgical pencil according to any one of claims 7 to 10, wherein the shroud further comprises a pair of vent holes on opposed sides of the distal end of the shroud.

12. A smoke evacuation shroud assembly according to claim 11, wherein each vent hole comprises a slit inclined to the common longitudinal axis of the shroud and the electrode.

13. An electrosurgical pencil according to claim 1 or claim 7, wherein the connector is integrally attached to the elongate body of the electrosurgical pencil.

14. A smoke evacuation shroud assembly for an electrosurgical pencil, the smoke evacuation shroud assembly comprising a smoke evacuation shroud for surrounding an electrode of the electrosurgical pencil and a connector for mounting the shroud to an elongate body of the surgical pencil, the connector having a connection element for connection to an aspirator tube of a smoke evacuation apparatus, the shroud being removably connectable to the connector, the shroud comprising an elongate tube having a distal cylinder portion and a near enlarged portion which tapers in increasing width to define at its near end a fitting for releasably fitting the shroud and connector together in a substantially fluid-tight manner, with an inner surface of the fitting mating with an outer surface of the connector, and the connector having an opening into which the elongate body of the electrosurgical pencil can be fitted.

15. A smoke evacuation shroud assembly according to claim 14 wherein a releasable snap-fitment is provided between the shroud and the connector.

16. A smoke evacuation shroud assembly according to claim 14 or claim 15, wherein the extreme distal end of the shroud comprises an annular end surface which is inclined to the longitudinal axis of the electrode and the shroud.

17. A smoke evacuation shroud assembly according to any one of claims 14 to 16, wherein the electrode projects from the end of the shroud by a projection distance predetermined to ensure effective smoke evacuation.

18. A smoke evacuation shroud assembly according to any one of claims 14 to 17, wherein the shroud further comprises a pair of vent holes on opposed sides of the distal end of the shroud.

19. A smoke evacuation shroud assembly according to claim 18, wherein each vent hole comprises a slit inclined to the common longitudinal axis of the shroud and the electrode.

20. A smoke evacuation shroud assembly according to claim 14, wherein the connector has a first substantially circular opening on its near surface, which enables the

connector to be push fitted over the elongate body of the electrosurgical pencil in a secure fluid-tight manner, and a second substantially circular opening which is provided on its near side with the connecting element for connecting with an aspirator tube in a secure fluid-tight manner.

21. A smoke evacuation shroud assembly according to claim 20, wherein the first substantially circular opening has an inner surface which is rigid and shaped and capable of mating with the outer surface of the elongate body in a fluid-tight manner.

22. A smoke evacuation shroud assembly according to claim 20, wherein the first substantially circular opening has an inner surface which is flexible and deformable and is capable of being conformed to the shape and dimensions of the outer surface of the elongate body to provide a fluid-tight fitting between the elongate body and the connector.

23. A smoke evacuation shroud assembly according to any one of claims 14 to 22, which further comprises a biasing means for applying a pulling force on the connector, and thereby the shroud attached thereto, for pulling the connector and the shroud rearwardly onto the electrosurgical pencil to ensure a secure fitment therebetween at a precise longitudinal position.

24. A smoke evacuation shroud assembly according to claim 23, further comprising an aspirator tube connected to the connector element which wholly or partly comprises an elastic material, the elastic material comprising the biasing means.

25. An electrosurgical pencil according to any one of claims 14 to 19, wherein the connector is integrally attached to the elongate body of the electrosurgical pencil.

26. A smoke evacuation apparatus for an electrosurgical pencil, the apparatus comprising a suction pump, an inlet filter for the suction pump for connection to an aspirator tube of an electrosurgical pencil, the inlet filter being adapted to filter particulate material and liquid from the aspirated air in the aspirator tube, and an outlet filter for the suction pump, the outlet filter being adapted to filter particulate material and odour from the air outputted by the pump.

27. A smoke evacuation apparatus according to claim 26, wherein the inlet filter comprises a first upstream filter, for filtering particulate material, and a second downstream hydrophobic filter.

28. A smoke evacuation apparatus according to claim 27, wherein the two filters of the inlet filter are mounted in a serial fashion within a common housing which is removably fitted into a cup which itself is removably fitted into a correspondingly shaped cavity in the exterior of the apparatus.

29. A smoke evacuation apparatus according to any one of claims 26 to 28, wherein the outlet filter comprises a carbon filter.

30. A smoke evacuation apparatus according to any one of claims 26 to 29, wherein the outlet filter is removably fitted into a cup which itself is removably fitted into a correspondingly shaped cavity in the exterior of the apparatus.

31. A smoke evacuation apparatus for an electrosurgical pencil, the apparatus comprising a suction pump for connection to an aspirator tube of an electrosurgical pencil, and a current detector for detecting electrical current in a cable of an electrosurgical pencil and operable to control the operation of the pump, the current detector comprising an annular ferrite body defining a central bore therethrough, and the body being selectively separable into a plurality of portions to open the central bore for placement of the cable therein.

32. A smoke evacuation apparatus according to claim 31, wherein the current detector further comprises a housing for the annular ferrite body, and wherein the annular ferrite body is a tube longitudinally split into two halves.

33. A smoke evacuation apparatus according to claim 32, wherein the housing further comprises a locking mechanism.

34. A smoke evacuation apparatus according to claim 32 or claim 33, wherein the housing is hinged.

35. An electrosurgical pencil substantially as hereinbefore described with reference to Figures 1 to 6 or Figures 7 to 9 of the accompanying drawings.

36. A smoke evacuation shroud assembly for an electrosurgical pencil substantially as hereinbefore described with reference to Figures 1 to 6 Figures 7 to 9 of the accompanying drawings.

37. A smoke evacuation apparatus for an electrosurgical pencil substantially as hereinbefore described with reference to Figures 10 to 13 of the accompanying drawings.

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Claims searched:	1, not 14, 26 or 31		**Date of search:**	3 December 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 at least	US5224944 A (ELLIOTT) See the whole document, especially the figures
X	1 at least	US5154709 A (JOHNSON) See especially the abstract and figure 3
X	1 at least	US6458125 B (I.C. MEDICAL) See abstract, figures 8a-8g
A	-	EP0447121 A2 (VALLEYLAB) See abstract and figures 18, 19
A	-	US5451222 A (DESENTECH) See whole diocument, especially figures 1-3 and abstract.
A	-	US6146353 A (SHERWOOD) See figures and abstract
A	-	GB2380679 A (ESCHMANN) See abstract and figures

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X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

A5R

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A61B

The following online and other databases have been used in the preparation of this search report

Online : WPI EPODOC JAPIO